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SCULLY SCOTT MURPHY & PRESSER, PC
400 GARDEN CITY PLAZA
SUITE 300
GARDEN CITY, NY 11530

EXAMINER	
MONDT, JOHANNES P	

ART UNIT	PAPER NUMBER
2826	

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Please find below and/or attached an Office communication concerning this application or proceeding.

AK

Office Action Summary	Application No.	Applicant(s)	
	10/775,514	CHU ET AL.	
	Examiner	Art Unit	
	Johannes P. Mondt	2826	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *15 July 2005*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *29-60* is/are pending in the application.

4a) Of the above claim(s) *42-59* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *29-32 and 60* is/are rejected.

7)☒ Claim(s) *33-41* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *10 February 2004* is/are: a)☐ accepted or b)☒ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date *7/15/05*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Amendment filed 7/15/05 forms the basis for this office action. In said Amendment Applicants substantially amended all previously presented claims 29-59 and added new claim 60. Comments on Remarks in said Amendment are included below under "Response to Arguments".

Information Disclosure Statement

The information disclosure statement filed 7/15/05 fails to comply with 37 CFR 1.98(a)(2), which requires a legible copy of each cited foreign patent document; each non-patent literature publication or that portion which caused it to be listed; and all other information or that portion which caused it to be listed. Copy of Kasper et al (item AG) is not at all readable. It has been placed in the application file, but the information referred to therein has not been considered, except for all other items listed thereon, i.e., items previously considered (see previous office action) and Kanzawa et al (item AC).

Drawings

1. *The drawings are objected to* under 37 CFR 1.83(a). The drawings must show every feature of the invention specified in the claims. Therefore, the "said Si/SiC interface having an abrupt change in C concentration of more than 1×10^{18} atoms/cc over a layer thickness in the range from about 6 Å to about 60 Å" as recited in claims 29-42 must be shown or the feature canceled from the claims. No new matter should be entered.

Corrected drawing sheets in compliance with 37 CFR 1.121(d) are required in reply to the Office action to avoid abandonment of the application. Any amended replacement drawing sheet should include all of the figures appearing on the immediate prior version of the sheet, even if only one figure is being amended. The figure or figure number of an amended drawing should not be labeled as "amended." If a drawing figure is to be canceled, the appropriate figure must be removed from the replacement sheet, and where necessary, the remaining figures must be renumbered and appropriate changes made to the brief description of the several views of the drawings for consistency. Additional replacement sheets may be necessary to show the renumbering of the remaining figures. Each drawing sheet submitted after the filing date of an application must be labeled in the top margin as either "Replacement Sheet" or "New Sheet" pursuant to 37 CFR 1.121(d). If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

Claim Rejections - 35 USC § 103

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

3. ***Claim 29*** is rejected under 35 U.S.C. 103(a) as being unpatentable over Swanson et al (6,552,375 B2). Swanson et al teach a layered structure comprising: a

substrate 202/204/206 having an upper surface of single crystalline Si (the upper surface 206 is single crystalline, see note below) (col. 5, l. 49 – col. 6, l. 12 and col. 4, l. 66 – col. 5, l. 12: N.B.: lattice mismatch between the collector 206 and any other layer above it is disclosed: for this there has to be a definite lattice constant value on its upper surface), a layer of SiC 218 (col. 6, l. 52-65) over said upper surface, said layer of SiC and said upper surface of single crystalline Si (interface between 218 and Si buffer 216: col. 6, l. 1-5) defining an interface having an abrupt change in C concentration of more than 1×10^{18} atoms/cc over a layer thickness that overlaps with the claimed range of 6 to 60 Å (N.B.: the atomic number density of silicon is 5×10^{22} atoms/cc; the range of the stoichiometric parameter X in $Si_{1-x}C_x$ (for instance X=0.002 corresponds to a concentration of 0.002 times said atomic number density, i.e., 1×10^{20} atoms/cc and the relation between X versus concentration is linear throughout the range) overlaps with the range as claimed; while the thickness is about 0 – 100 Å, in particular 50 Å: see col. 6, l. 26-43) in 216, it can be concluded that said interface has an abrupt change in C concentration as claimed and over a layer thickness that overlaps with the claimed range.

Applicant is reminded that a *prima facie* case of obviousness typically exists when the ranges of a claimed composition overlap the ranges disclosed in the prior art or when the ranges of a claimed composition do not overlap but are close enough such that one skilled in the art would have expected them to have the same properties. In re Peterson, 65 USPQ2d 1379 (CA FC 2003).

Because the stoichiometric quantification of said interface layer 216 is characterized by zero oxygen concentration the final limitation of claim 29 is also met.

Parenthetically, is noted that the stoichiometric formula $Si_{1-x}C_x$ with great accuracy defines the composition, and does not include any oxygen (loc.cit., see above, in particular col. 6, l. 52-65).

4. ***Claim 30*** is rejected under 35 U.S.C. 103(a) as being unpatentable over Swanson et al as applied to claim 29 above, and further in view of Shindo et al (6,137,120). As detailed above, claim 29 is unpatentable over Swanson et al. Swanson et al do not teach the further limitation defined by claim 29. However, it would have been obvious to include said further limitation in view of Shindo et al, who, in a patent on a bipolar transistor (72^{nd} aspect of the invention) teach a bipolar transistor (col. 64, l. 26-33) with single crystalline emitter, base and/or collector regions so as to improve electron mobility (col. 68, l. 31-40). *Motivation* to include said teaching by Shindo et al derives from the improvement of device speed and reduced ohmic dissipation through enhanced electron mobility by virtue of the dependence on transit time on mobility and the linear relationship between conductivity and electron mobility.

5. ***Claim 31*** is rejected under 35 U.S.C. 103(a) as being unpatentable over Swanson et al as applied to claim 29 above, and further in view of Tay et al (5,296,258). As detailed above, claim 29 is unpatentable over Swanson et al. Swanson et al do not necessarily teach the further limitation as defined by claim 31. However, it would have been obvious to include said further limitation in view of Tay et al, who, in a patent on a silicon carbide BiCMOS device (title and abstract) teach the selection of the CVD based

polycrystalline state for the SiC emitter region 20 (col. 5, l. 10-20 and col. 9, l. 38-42) which has the advantage of relative ease of making (only a 200 degree difference in heating during the anneal is needed to achieve polycrystallinity) needed for the consequent improvement of the charge carrier mobility. *Motivation* thus stems from the achieved improvement in speed at moderate cost.

6. ***Claim 32*** is rejected under 35 U.S.C. 103(a) as being unpatentable over Swanson et al as applied to claim 29 above, and further in view of Fang et al (6,114,745). As detailed above, claim 29 is unpatentable over Swanson et al. Swanson et al do not necessarily teach the further limitation defined by claim 32. However, it would have been obvious to include said further limitation in view of Fang et al, who teach the SiC emitter region 40 in a bipolar transistor to be topped by an abutting silicon layer 38 so as to create an emitter contact region (col. 3, l. 2-31). Inclusion of the teaching in this regard by Fang et al in the invention by Swanson implies the selection of polysilicon, hence of silicon, for emitter contact region 126 and is motivated by the more gradual transition in resistivity between the emitter electrode and the silicon carbide portion of the emitter, thus lowering the contact potential, which is the essence of any contact region.

6. ***Claim 60*** is rejected under 35 U.S.C. 103(a) as being unpatentable over Swanson et al (6,552,375 B2). Swanson et al teach a layered structure comprising: a substrate 202/204/206 having an upper surface of single crystalline Si (the upper surface 206 is single crystalline, see note below) (col. 5, l. 49 – col. 6, l. 12 and col. 4, l. 66 – col. 5, l. 12: N.B.: lattice mismatch between the collector 206 and any other layer

above it is disclosed: for this there has to be a definite lattice constant value on its upper surface), one or more layers of materials selected from the group consisting of Si, SiGe, SiC and SiGeC (namely: SiC 218 (col. 6, l. 52-65)), wherein said one or more material layers comprise at least one layer of SiC or SiGeC (namely: SiC layer 218) (loc.cit.) over said upper surface, and said one or more layers and said upper surface of single crystalline Si define one or more interfaces having an abrupt change in C concentration of more than 1×10^{18} atoms/cc over a layer thickness that overlaps with the claimed range of 6 to 60 Å (N.B.: the atomic number density of silicon is 5×10^{22} atoms/cc; the range of the stoichiometric parameter X in $Si_{1-x}C_x$ (for instance X=0.002 corresponds to a concentration of 0.002 times said atomic number density, i.e., 1×10^{20} atoms/cc and the relation between X versus concentration is linear throughout the range) overlaps with the range as claimed; while the thickness is about 0 – 100 Å, in particular 50 Å: see col. 6, l. 26-43) in 216, it can be concluded that said interface has an abrupt change in C concentration as claimed and over a layer thickness that overlaps with the claimed range.

Because the stoichiometric quantification of said interface layer 216 is characterized by zero oxygen concentration the final limitation of claim 29 is also met.

Parenthetically, is noted that the stoichiometric formula $Si_{1-x}C_x$ with great accuracy defines the composition, and does not include any oxygen (loc.cit., see above, in particular col. 6, l. 52-65).

Applicant is reminded that a *prima facie* case of obviousness typically exists when the ranges of a claimed composition overlap the ranges disclosed in the prior art

or when the ranges of a claimed composition do not overlap but are close enough such that one skilled in the art would have expected them to have the same properties. In re Peterson, 65 USPQ2d 1379 (CA FC 2003).

Finally, Applicants are herewith reminded of the election of species requirement and their election of Species 1. Because of said election newly added claim 60 only at most patentably distinguishes over claim 21 through the limitation "one or more layers" (of SiC) instead of "a layer" (of SiC) and the limitation "one or more interfaces" instead of the limitation "an interface".

Response to Arguments

Applicant's arguments filed 7/15/05 have been fully considered but they are not persuasive. In particular, counter to Applicants' argument that "nothing in Swanson teaches or suggests formation of a SiC with an oxygen concentration in the claimed range, the stoichiometric expression for said $Si_{1-x}C_x$ layer is highly accurate and does not include any oxygen.

Furthermore, the particular reason why oxygen concentrations fall in the range as claimed in Applicants' invention is related to a particular method that is irrelevant to the device claims as elected by Applicant, as opposed to a method invention, by original representation.

Also, counter to Applicants' allegation that the SiC layer 218 in Swanson is made by VPE, Swanson states that the "diffusion blocking layer 218 " may be formed by "other processes", specifically reciting *inter alia* limited reaction processing, molecular beam epitaxy and laser melting: see, e.g., Sexton et al (5,225,371) for a discussion why

laser melting, a method by which oxygen is not employed at all, reduces contamination problems (see title and abstract) and can be applied specifically to the formation of SiC (columns 3-4, specifically col. 4, l. 48-53).

In conclusion on the art rejections under 35 U.S.C. 103(a), all arguments in traverse of the rejections fail to persuade and said rejections also apply to the substantially amended claim language, said substantially amended claim language only being successful in overcoming the rejection under 35 U.S.C. 112, second paragraph.

Furthermore, the objection to the Drawings is herewith repeated despite arguments by Applicants for the following reason: although Applicants argue that "such alternative silicon-containing regions define interfaces therebetween, which are clearly shown in Figures 1 and 2, where the C concentration changes abruptly", with which examiner agrees, Applicants also argue that said interfaces are shown "within a depth of less than 0.1 micron (as shown in Fig. 1)", which is arguably true based on Figure 1, but highly insufficient to "show every feature of the invention specified in the claims", as required by 37 C.F.R. 1.83(a), because 0.1 micron = 10^3 Å, and therefore any detail even remotely on the scale of the claimed range of 6 to 60 Å is wholly undisclosed by Figure 1, nor is it disclosed by any other Drawing.

Allowable Subject Matter

a. ***Claims 33-38, 40 and 41*** are objected to as being dependent upon a rejected base claim, but, subject to a successful removal of the reasons for the objection to the Drawings as made above, would be allowable if rewritten in independent form including all of the limitations of the base claim and any

intervening claims. The following is a statement of reasons for the indication of allowable subject matter: within the context of the invention as defined by claim 29 the p-type and n-type dopants of said SiC layer were not found in the prior art to have the concentration as recited in claims 33 and 34, respectively.

b. ***Claim 39*** is objected to as being dependent upon a base claim, but, subject to a successful removal of the reasons for the objection to the Drawings as made above, would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims. The following is a statement of reasons for the indication of allowable subject matter: within the context of the invention as defined by claim 29 the S:Ge layer as recited in claim 39 has not been found in the prior art.

Conclusion

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of

the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Johannes P. Mondt whose telephone number is 571-272-1919. The examiner can normally be reached on 8:00 - 18:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nathan J. Flynn can be reached on 571-272-1915. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

NATHAN J. FLYNN
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 2800

JPM
September 24, 2005